GCEP SURE 1999 Los Alamos National Lab, New Mexico Shelby Winiecki

Data Quality Improvement Studies at ARM TWP

- ★ Mentor: Bill Porch
- Summer Goals:
 - Understand radiative transfer
 - * Exposure to Fortran and other programming languages widely used in Atmospheric Science
 - ★ Take full advantage of spending a summer in New Mexico
- Research Objectives:
 - Improve the quality of the data.
 - Improve the accuracy of the measurements taken by the instruments used at the TWP field site which will in turn improve data quality

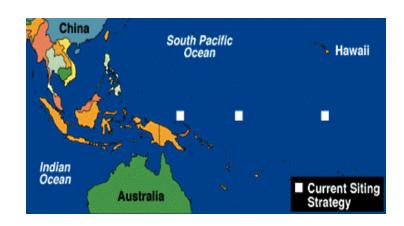
Atmospheric Radiation Measurement (ARM) Tropical Western Pacific Field Site



- ★ The ARM Program is part of DOE's effort to resolve scientific uncertainties about global climate change with a specific focus on improving the performance of general circulation models (GCMs) used for climate research and prediction.
 - ARM scientists focus on obtaining field measurements and developing models to better understand the processes that control solar and thermal infrared radiative transfer in the atmosphere (especially in clouds) and at the earth's surface.



The TWP consistently has the warmest sea surface temperatures on the planet and is referred to as the Pacific "warm pool." The warm pool supplies heat and moisture to the atmosphere above it, resulting in the formation of deep convective cloud systems, which, in turn, produce high altitude cirrus clouds that spread out over much of the region. The interaction of these cloud systems with ocean and air temperatures regulate the amount of solar energy reaching the surface of the earth. Improved understanding of the interaction between clouds and incoming and outgoing energy will improve the general circulation models used for climate research.



Global Energy Budget

★ These percentages are only estimates of the various processes affecting the climate. The uncertainty of incoming, reflected, and outgoing radiation is greater than the estimated effect of doubling CO₂. Therefore, instrument calibration is an extremely important aspect of the ARM program.

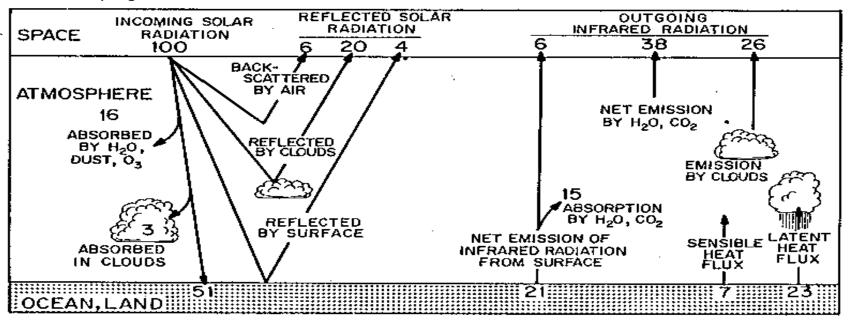


Figure The annual mean global energy balance for the earth-atmosphere system. (Numbers are given as percentages of the globally averaged solar irradiance incidence upon the top of the atmosphere.)

Source: http://cimss.ssec.wisc.edu/goes/comet/7.html

Radiative Transfer

- ★ The amount of solar radiation reaching the earth's surface varies greatly because of the changing atmospheric conditions and the changing position of the sun both during the day and throughout the year.
- Atmospheric conditions include both anthropogenic and naturally occurring events such as cloud cover, urban air pollution, smoke from forest fires and airborne ash resulting from volcanic activity. These effects decrease the amount of direct solar radiation, but have little influence on global solar radiation. The third means by which the earth receives UV radiation is referred to as diffuse solar radiation.
- ★ GLOBAL = DIRECT*(COS _) + DIFFUSE (where _ is the zenith angle, _ is zero when the sun is directly above and perpendicular to the earth's surface)
- ★ Measuring all three quantities provides sufficient information for understanding the solar resource and for rigorous quality assessment of the data.
- ★ Source: Shining on: A Primer on Solar Radiation Data

The Solar Spectrum

- ★ The Solar Spectrum shows the wavelengths at which different atmospheric gases absorb radiation. For example, when there are high amounts of ozone in the atmosphere: at a wavelength of about .6 _m, a large amount of solar radiation will be absorbed leaving less solar radiation reaching the surface.
- ★ The MFRSR measures the solar radiation at all these wavelengths and allows estimation of the effect of atmospheric aerosols.
- Now, one can see that the particle (size and quantity) and the wavelength are directly related to the amount of solar radiation the earth receives.

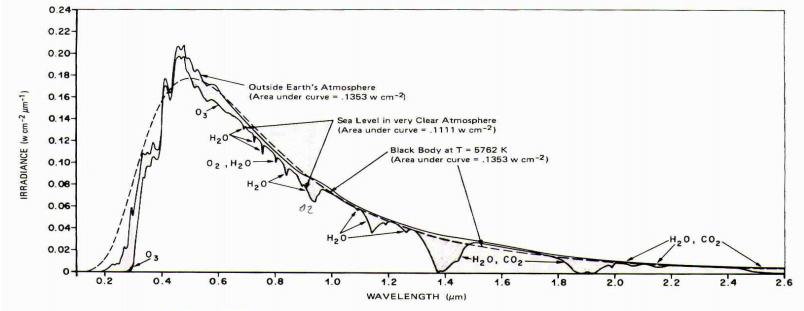
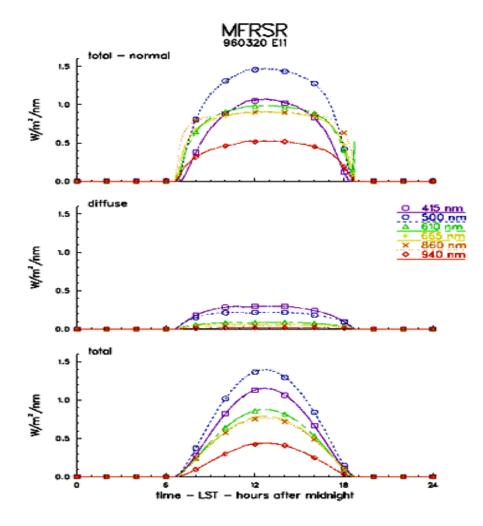


FIG. 4.5. Solar spectral irradiance normally incident at sea level on very clear, dry (0.5 cm of precipitable water vapor) days, solar spectral irradiance outside the Earth's atmosphere at 1 AU and blackbody spectral irradiance curve at T = 5762K (normalized to 1 AU).

Radiometric Instruments: Multifilter Rotating Shadowband Radiometer (MFRSR)



- ★ The MFRSR takes spectral measurements of direct normal, diffuse horizontal, and global solar irradiances. These measurements are at nominal wavelengths of 415, 500, 610, 665, 862 and 940 nm.
- ★ From such measurements, one may infer the atmosphere's optical thickness at the wavelengths mentioned above.



Optical Thickness & Radiative Transfer Code

- ★ Optical thickness is a measure of how much or how little sunlight is able to cross the atmosphere.
- ★ In the radiative transfer code that we are using, we have created a model atmosphere based upon measurements made of the atmosphere in the tropics.
- ★ Based upon absorption characteristics, generally described by the solar spectrum (above) we can change the size of the particle and the wavelength to get an accurate measurement of the optical thickness.
- ★ Because the Rayleigh scattering (the scattering of gaseous particles) is a known value at each wavelength, the total optical thickness being calculated by the model is only that of particle scattering, or Mie scattering. Therefore, when we are certain that the number of aerosols we are putting into our model matches that of an actual tropical atmosphere, we can be certain that the optical thickness of the model is accurate. At this point we can correct for any inaccuracies in the MFRSR.
- Through our work this summer utilizing radiation transfer code and data from the TWP field site, we have discovered a significant difference in the aerosol optical properties in the tropics as compared mid-latitudes (blue moon scattering).

Acknowledgements

- ★ To my mentor, Bill Porch, for his patience and guidance throughout the summer.
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